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Title: MULTI-COMPONENT COEXTRUSION

TECHNICAL FIELD

This invention relates to methods and apparatus for forming a multiple component, composite polymer/wood fiber extrusion and a method for making the same. More specifically, the invention relates to a composite extrusion of the type described above having a multiplicity of components, including a high density, substantially hollow extrusion profile having inner and/or outer components having a different density coextruded with the high density component.

BACKGROUND OF THE INVENTION

Milled wood products have formed the foundation for the fenestration, decking and remodeling industries for many years. Historically, ponderosa pine, fir, red wood, cedar and other coniferous varieties of soft woods have been employed with respect to the manufacture of residential window frames, residential siding and outer decking. Wood products of this type inherently possess the advantageous characteristics of high flexural modulus, good screw retention, easy workability (e.g., milling, cutting, paintability), and for many years, low cost. Conversely, wood products of this type have also suffered from poor weatherability in harsh climates, potential insect infestation such as termites, and high thermal conductivity. In addition to these inherent disadvantages, virgin wood resources have become scarce, thus the raw material cost for milled wood products has become correspondingly expensive.

In response to the above described disadvantages of milled wood products, the fenestration industry, in particular, adopted polyvinyl chloride as a raw material

for the manufacture of hollow, lineal extrusions for subsequent assembly into window frames. Window frames manufactured from such lineal extrusions became an enormous commercial success, particularly at the lower end of the price spectrum. Window frames manufactured from hollow, lineal polyvinyl chloride (PVC) extrusions exhibited superior thermal conductivity, water absorption resistance (and thus rot resistance), insect resistance, and ultraviolet radiation resistance compared to painted ponderosa pine. Although such extrusions further enjoyed a significant cost advantage over comparable milled wood products, these polymer based products had a significantly lower flexural modulus (i.e., bending moment), were difficult if not impossible to paint effectively, and had a significantly higher coefficient of thermal expansion. By the mid 1990s, a number of window and door frame manufacturers attempted to combine the most desirable characteristics of extruded thermoplastic polymers and solid wood frame members by alloying PVC with wood fiber in an extruded product.

U.S. Patent No. 5,486,553 to Deaner et al. discloses an extruded polymer/wood fiber thermoplastic composite structural member, suitable for use as a replacement for a wood structural member, such as for window frame components. The preferred thermoplastic component is polyvinyl chloride (PVC), and the preferred wood fiber component is sawdust. In a preferred embodiment of the invention, a double hung window unit is disclosed having cell, jamb and header portions comprising hollow, multi-compartment lineal extrusions which can be made from the disclosed thermoplastic polymer/wood fiber composite. The resulting extrusion has mechanical properties which are similar to wood, but have superior dimensional stability, and resistance to rot and insect damage as compared to conventional wood products.

Problems relating to co-extrusion of wood fibers and a thermoplastic polymer component are well explained in

United States Patent No. 5,851,469 to Muller et al. issued December 22, 1998, the disclosure of which is incorporated herein by reference. Muller et al. described the typical prior art steps for co-extruding a thermoplastic polymer with wood fiber. In a first step, the wood fiber is dried using conventional techniques to a moisture content of less than 8% by weight. In a second step the wood fiber and plastic material are preheated to a temperature of approximately 176° F. to 320° F. In a third step, the materials are mixed or kneaded at a temperature of 248° F. to 482° F. to form a paste. In a fourth and final step, the paste is either injection molded or extruded into a final form. If the paste is extruded, the extrudate must be calibrated and cooled. The Muller et al. reference specifically addresses the problem of controlling the temperature of the extrudate through various stages of the extrusion process to prevent undesirable sheer stresses from arising during the extrusion process. Muller et al. also teach that a particular problem involved with wood fiber/thermoplastic composite extrudates involves volatiles in the wood component boiling off at extrusion temperatures causing an undesirable foaming of the extrudate.

In addition, extruded polymer/ wood thermoplastic composite structural members allowed manufacturers to limit the amount of expensive thermoplastic materials used in the extrusion by increasing the percentage of low cost waste wood product incorporated into the process. Substantial advancements have been made in this art whereas as of the filing date of this application, concentrations of wood fiber in a hollow core, thermoplastic extrusion up to 30 to 40 percent are known. Unfortunately, adding significant quantities of wood fiber to the thermoplastic polymer/wood fiber composite degrades the flexural modulus (i.e., bending moment) of the extrusion. Thus, manufacturers often resort to the use of U-shaped metal channels which reside inside hollow

sections of the longitudinal extrusion to provide increased stiffness, as well as angled metal members incorporated into interior components of such structures and corners thereof. The use of such additional structural members disadvantageously increases the cost of assembling products of this type, as well as decreases the thermal efficiency of these products.

Some manufacturers have moved in a different direction by preparing foamed lineal extrusions, with and without a wood fiber content. Such extrusions address the difficulties in connecting thin wall, hollow extrusions at corners (typically done by thermal welding) by providing a large surface area for joining. In addition, screw retention and thermal efficiency may be substantially improved in foamed extrusions of this type. Further yet, foamed extrusions containing a high wood fiber content are readily paintable and can be provided with a surface texture which mimics solid wood. The assignee of the present invention has developed improved techniques for increasing the wood fiber content of such foamed extrusions as disclosed in United States Patent Application Serial No. 09/452,906, entitled "Wood Fiber Polymer Composite Extrusion and Method", filed December 1, 1999, the disclosure of which is incorporated herein by reference. Unfortunately, while such foamed lineal extrusions advantageously exhibit improved heat deflection, Vicat softening point, screw retention, and lower density (i.e., decreased raw material cost) as opposed to rigid, hollow core PVC extrusions, foamed extrudates typically have a lower flexural modulus than comparable rigid, thin walled, hollow core PVC extrusions.

In an attempt to combine the specific structural advantages of different types of polymers, at least one manufacturer in the fenestration industry has attempted to produce a multi-component extrusion having an extruded foamed material as one component, flexible flanges as another component, and a partial capstock as a third

component. An example of an extrusion of this type is disclosed in United States Patent No. 5,538,777 to Pauley et al. entitled "Triple Extruded Frame Profiles", issued July 23, 1996. That patent discloses a three- component extrusion for a window sash. The main component of the extrusion in cross-section is a polyvinyl chloride foam core, optionally including a fiber component. The core has a recess forming a U-shaped channel for receipt of glass panes. The panes are held in place by flexible flanges extending normal to the inside of the channel in the form of a flexible material which is used to form the flexible flanges and/or seals. Dupont Alcryn™ is disclosed as an appropriate material for the flanges. The extrusion is also disclosed as having a partial capstock, preferably acrylic styrene acrylonitrile (ASA) which is provided only on the portion of the exterior of the extrusion which will be exposed to weathering. Although this extrusion enjoys the low cost advantages of a foamed, thermoplastic/wood fiber core and the weatherability of a partial capstock, it is believed that an extrusion of this type has insufficient flexural modulus for use in anything other than as a sash portion of a window assembly. That is, it is believed that metallic channel stiffeners, and the like, would still be necessary if this type of extrusion construction was employed as a main frame element.

Thus, a need exists for a lineal extrusion for use in the fenestration, decking and remodeling industries which combines a low raw material cost with high tensile, compressive, bending moment, and impact strength; improved weldability with respect to hollow core extrusions; high wood fiber content (reduced cost); and high workability (e.g., millable, paintable, and good screw retention). In addition, there is a need for an extrusion of the type described above which is highly durable, being resistant to rot, mildew, and ultraviolet degradation.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a continuous, lineal multi-component polymer composite extrusion having low raw material cost; high tensile, compressive, bending moment, and impact strength; improved weldability with respect to hollow core extrusions; high wood fiber content; and high workability.

It is a further object of the present invention to achieve the above object by a method and apparatus which provides a continuous, lineal multi-component polymer composite extrusion which is highly durable, being resistant to rot, mildew, and ultraviolet degradation.

It is yet a further object of the invention to achieve the above objects with a manufacturing process capable of varying the ultimate macroscopic properties of the resulting extrudate so as to closely match the differing physical requirements of the fenestration, decking and siding markets.

The invention achieves the above objects and advantages, and other objects and advantages which will become apparent from the description which follows, by providing a multi-component, longitudinally continuous extrusion having a first, high density, thin wall composite member having a thermoplastic component and a cellulosic fiber component. The inventive extrusion further has a second, low density foamed member, consisting of a foamed, thermoplastic polymer coextruded with the first member in a plastic state, substantially contemporaneously with the first member, in an extrusion die so as to be laterally coextensive with, and molecularly bonded to, either an inside hollow portion of the first, thin wall high density member, an outside of the first, thin wall, high density member, or both.

In the preferred embodiment, the inventive extrusion may be capped with a thin layer of acrylic styrene acrylonitrile (ASA) or polyvinyl chloride (PVC).

In alternate embodiments of the invention, the low density foamed member may include a substantial wood fiber content, particularly when the second, low density foamed member is on the outside of the first, thin wall, high density composite member and a thermoplastic cap is not employed. The thermoplastic cap may be provided with a highly weatherable, thermoplastic polymer on one side of the extrusion (to be exposed to the outdoor portion of a building) and a highly paintable thermoplastic polymer on an opposite side of the extrusion, to be exposed to an indoor portion of the building.

The invention includes apparatus in the form of a multi-plate extrusion die for manufacturing the above extrusions, including an introductory plate for passage therethrough of a primary extrudate from a principal extruder, a mandrel plate downstream of the introductory plate for receipt of the primary extrudate which will become the first, thin wall, high density composite member. The mandrel plate has suspended within an aperture therein a first elongated mandrel wherein the first mandrel is substantially hollow and has therein a second mandrel substantially suspended therein in a spaced apart relationship from the side walls of the first elongated mandrel so as to form an elongated, hollow interstitial void between the first and second mandrels. The interstitial void is thus available for introduction of the second, low density foamed material which can become laterally coextensive with, and molecularly bonded to, one of the inner side walls of the first member. Finally, a secondary plate is positioned between the introductory and mandrel plates so that in one alternate, preferred embodiment of the invention the second, low density foamed extrudate can be provided on the outer side wall of the first, thin wall, high density composite member so that foamed material can be provided on both the inside and the outside of the thin wall extrusion, as well as on the inside or the outside of the hollow core

extrusion exclusively. A capstock plate can be provided downstream of the mandrel plate for adding a third extrudate in the form of a capstock to the final extrudate. Elongated, tapered fins are preferably provided to support the first elongated mandrel with respect to the aperture in the mandrel and also to support the second mandrel in a spaced apart relationship with respect to inner side walls of the first hollow mandrel.

The invention includes a method of making the above described multi-component, longitudinally continuous extrusion with the above described introductory, mandrel, and secondary die plates which includes the steps of preparing a thermoplastic primary extrudate and a secondary thermoplastic extrudate, introducing the primary extrudate in a plastic state into the introductory plate, positioning a mandrel plate downstream of the introductory plate, and introducing the secondary extrudate in a plastic state into a void between the first and second, coaxially spaced mandrels in the mandrel plate, so that an elongated final extrudate having at least two different longitudinally continuous, molecularly bonded thermoplastic components exit the mandrel plate.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an environmental view of a first embodiment of a multi-component, polymer composite extrusion of the present invention.

Figure 2 is a an exploded schematic representation of a plurality of extrusion die plates employed in the manufacture of the extrusion shown in Figure 1.

Figure 3 is a left hand, environmental view of a mandrel plate die of the die shown in Figure 2.

Figure 4a is a right hand perspective view of the mandrel plate die shown in Figure 3.

Figure 4b is a left hand perspective view of a floating mandrel of the mandrel die shown in Figure 4a.

Figure 4c is a right hand perspective view of the floating mandrel shown in the mandrel die of Figure 4a.

Figure 5 is a schematic representation of a polymer flow in a plastic state in the die assembly shown in Figure 2.

Figure 6 is an environmental view of a second embodiment of a multi-component, polymer composite extrusion of the present invention.

Figure 7a is a right hand, perspective view of a mandrel plate having a dual floating mandrel therein for manufacture of the extrudate shown in Figure 6 in conjunction with some of the die plates shown in the die plate assembly of Figure 2.

Figure 7b is a left hand environmental view of a mandrel plate having a dual floating mandrel therein for manufacture of the extrudate shown in Figure 6 in conjunction with some of the die plates shown in the die plate assembly of Figure 2.

Figure 8a is an enlarged, right hand perspective view of the dual floating mandrel shown in Figure 7a.

Figure 8b is a left hand perspective view of the dual floating mandrel shown in corresponding Figure 7b.

Figure 9 is a schematic representation of a third alternate embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A first preferred embodiment of a multi-component, composite polymer/wood fiber continuous lineal extrusion of the present invention is generally indicated at reference numeral 10 of Figure 1. The extrusion includes a first, high density, thin wall component 12, having an inner side wall 14 defining at least one hollow section in profile. The multi-component extrusion 10 further has a second, low density foamed thermoplastic member 16 which is coextruded with, and substantially fills, the hollow section defined by inner side wall 14. As will be

described in further detail hereinbelow, the second component 16 is preferably formed of a foamed thermoplastic member which is molecularly bonded to, and substantially laterally coextensive with, the inner sidewall 14. In this preferred embodiment, the first component 12 has an outer side wall 18 defining the exterior surface of the first component. In this first preferred embodiment, the outer side wall 18 supports a thermoplastic cap 20 which is substantially coextruded with the first and second components 12, 14, so as to be molecularly bonded to the outer side wall 18. The thermoplastic cap is preferably formed from a highly weatherable, thermoplastic polymer such as polyvinyl chloride (PVC).

The multi-component, composite polymer/wood fiber extrusion 10 shown in Figure 1 is suitable for use as vertical and horizontal members of a window sash. The extrusion defines a substantially U-shaped channel, generally indicated at reference numeral 22, for the receipt of weatherstripping material, and the like (not shown). The extrusion 10 shown in Figure 1 also has on the upper portion thereof a substantially L-shaped surface 24, having a lower ledge 26 and at right angles thereto a vertical edge 28. When assembled into a window sash, the extrusion 10 is cut into four desired lengths, having each end of each section mitered at an appropriate angle. The mitered edges are then thermally welded in a manner well known to those of ordinary skill in the art so as to form a complete sash frame. Extrusion 10 of the present invention advantageously presents a cross-section at each miter joint having a substantially continuous surface of thermoplastic material. Thus, the entire cross-sectional surface area available for thermal welding is substantially greater than that of a continuous lineal extrusion being substantially hollow in profile. In addition, it is relatively easy to align adjacent members

of the sash because of the large surface area available for welding.

In the context of a complete sash structure, the lower edge 26 of the extrusion 10 is well adapted to receive edges of glass panes (not shown) in a moveable or fixed sash. Vertical edge 28 provides a support surface for a rearward pane member of, for example, a double-pane sash. The extrusion 10 is also provided on a forward edge thereof with a bead pocket, generally indicated at reference numeral 30, for receipt of a bead (not shown) for retaining an outer pane of a double pane window sash. Thus, the completed sash defines an exterior surface 32 for the sash and an interior surface 34. In this embodiment, the exterior surface 32 is exposed to weathering, while the interior surface 34 [extending from the vertical edge 28 around the rear (hidden in Figure 1) surface of the thermoplastic cap 20] is exposed to the interior of a home or the like. The thermoplastic cap 20 may therefore be preferably provided with the interior surface 34 being extruded from a thermoplastic polymer that is highly paintable, whereas the exterior surface 32 is extruded with a thermoplastic polymer that is highly weatherable.

Figure 2 illustrates a die assembly 40 consisting of a series of individual die plates, 44, 46, 48, 50, 52, 54, 56, and 58, for manufacturing the multi-component extrusion 10 shown in Figure 1. The manner of use of such dies is well known to those of ordinary skill in the thermoplastic extrusion art and is well described in United States Patent Application Serial No. 09/452,906, entitled "Wood Fiber Polymer Composite Extrusion and Method" assigned to the assignee of the present invention. Disclosure of that application is incorporated herein by reference. Nevertheless, it is sufficient to state that the die assembly 40 shown in Figure 2 is intended for use with a plurality of conventional extruders, such as conventional twin screw extruders, each of which includes

a hopper or mixer for accepting a feed stock consisting of a thermoplastic polymer and/or wood composite pelletized material, a conduit for connecting the hopper with a preheater for controlling the temperature of an admixture of the feed stock in the hopper, and optionally an inlet for introducing foaming agents in the case of a foamed component. The preheater is fluidly connected to a multi-screw chamber for admixing feedstock with the foaming agent (if present) and other conditioners to be described hereinbelow under controlled conditions of temperature and pressure. The multi-screw chamber of each extruder is connected to an appropriate one of the die assembly plates shown in Figure 2 for producing the multi-component extrusion 10 shown in Figure 1. The extrudate is then preferably calibrated in a conventional calibrator to result in a final product shown in Figure 1. Appropriate extruding machines are available from Cincinnati Millacron Corporation, Batavia, Ohio, USA.

As best seen in Figure 2, one of the hereinabove described extruders (not shown) is fluidly connected to an introductory plate 44 for introduction of a primary extrudate which will become the hollow high density component 12 shown in Figure 1. The primary extrudate is introduced through a primary aperture 60 in the introductory plate 44. A first shaping plate 46 has a plurality of internal conduits 47 for directing the flow of the primary extrudate to corresponding conduits in a secondary extrudate die plate 48. Secondary extrudate die plate 48 has an inlet 49 for introduction of a secondary extrudate which will become the second, low density foamed thermoplastic component 16 of the extrusion shown in Figure 1. The inlet 49 is fluidly connected to a secondary shaping die plate 50 by way of an internal secondary conduit 51. Both the internal primary and secondary conduits 47, 51 are in fluid communication with a mandrel plate 52 which supports a first mandrel 53(a) by means of a plurality of longitudinally elongated fins

53(b) within the internal primary conduit 47. An external surface 53(c) of the first mandrel 53(a) is the inner forming surface for the primary extrudate. As best seen in Figures 3 & 4(a)- 4(c), the first mandrel 53(a) is substantially hollow and has suspended therein a second mandrel 53(d). The second mandrel 53(d) is suspended within the hollow interior of the first mandrel 53(a) by elongated, longitudinally tapering fins 53(e). Thus, the first and second mandrels 53(a) and 53(d) form a two-stage floating mandrel within the internal primary conduit 47. The secondary extrudate which will ultimately comprise the second, low density foamed thermoplastic component 16 of the multi-component extrusion 10 of Figure 1 enters the die assembly 40 of Figure 2 through the secondary extrudate inlet 49, the internal secondary conduit 51, and then the voids formed between the first and second mandrels. A mandrel shaping plate 54 is positioned adjacent to the mandrel plate 52 and is in fluid communication therewith for further shaping the principal extrudate about the external surface 53(c) of the first mandrel 53(a). The tapering fins 53(e) taper in thickness from the maximum thickness shown in Figure 4b to a thin edge (hidden from view) approximately one-quarter of the length of the first and second mandrels in a manner well known to those of ordinary skill in the art so that at the exit end of the first and second mandrels the fins end and are absent from the void 55. The die assembly 40 further includes first and second capstocking dies 56, 58, having corresponding first and second internal channels 57, 59 for introduction of a third extrudate in the form of a capstock from a third extruder (not shown) through capstocking inlet 62 in first capstock die 56, as best seen in Figure 5.

Figure 5 is a schematic representation of extrudate flow through die assembly 40, illustrating flow of the primary extrudate 64, the secondary extrudate 66, and the third extrudate 68. As stated above, the primary

extrudate forms the thin wall, high density, hollow component 12; the secondary extrudate forms the second, low density foamed thermoplastic component 16; and the third extrudate forms the thermoplastic cap 20 of the extrusion 10 shown in Figure 1.

Table 1 hereinbelow illustrates one preferred formulation used for the principal extrudate used in the production of the thin wall, high density hollow component 12, shown in Figure 1. In this preferred embodiment, the thin wall, high density hollow component 12 consists of a polyvinyl chloride (PVC)/wood flour composite. The inclusion of wood flour is preferred, but nevertheless is optional.

TABLE 1
PVC/Wood Flour Composite

INGREDIENT	PERCENT	SUPPLIER	CITY	STATE
PVC resin	50.25	Shintech	Freeport	Texas
Stabilizer	0.75	Witco	Taft	Louisiana
Plasticizer	1.51	Kalama	Kalama	Washington
Process Aid TR-060	1.96	Struktol	Stow	Ohio
Lubricant PCS-351E	0.50	Morton	Cincinnati	Ohio
Modifier B-360	5.03	GE	Morgantown	West Virginia
Wood Flour (60 Mesh Pine)	40.00	American Wood Fiber	Schofield	Wisconsin

The secondary extrudate 66 which forms the second, low density foamed thermoplastic component 16 in the preferred embodiment shown in Figure 1 consists of a polyvinyl chloride (PVC) foamed core. Table II

illustrates one preferred formulation of the secondary extrudate 66.

TABLE II

PVC Foam Core

INGREDIENT	PERCENT	SUPPLIER	CITY	STATE
PVC resin SE 650	77.97	Shintech	Freeport	Texas
Stablizer MK 1915	1.25	Witco	Taft	Louisiana
Lubricant VGE-1875	1.55	Cognis	Kanakee	Illinois
Calcium Stearate	0.39	Synpro	Cleveland	Ohio
Lubricant AC-629A	0.12	Cognis	Kanakee	Illinois
Modifier PA-40	4.68	Kaneka	Pasadena	Texas
Titanium Dioxide	0.78	Huntsman Tioxide	Lake Charles	Louisiana
Filler UFT	2.34	OMYA	Florence	Vermont
Foaming Agent Hydrocerol	9.36	Clariant	Charlotte	North Carolina
Process Aid TR-060	1.56	Struktol	Stow	Ohio

A preferred formulation used for the third extrudate 68, forming the thermoplastic cap 20 in the multi-component extrusion 10 of Figure 1, is illustrated in Table III, wherein the thermoplastic has favorable weatherability characteristics.

TABLE III

PVC Cap

INGREDIENT	PERCENT	SUPPLIER	CITY	STATE
PVC Resin SE-650	76.161	Shintech	Freeport	Texas
Stabilizer	0.610	Witco	Taft	Louisiana
401P	0.228	PQ Corp.	Kansas City	Kansas
Lubricant VGE-3041	2.44	Cognis	Kanakee	Illinois
Anti-stat	0.38	Clariant		Germany
Modifier K-37	4.95	Kaneka	Pasadena	Texas
Calcium Carbonate	3.04	OMYA	Florence	Vermont
TiO2	7.62	Huntsman Tioxide	Lake Charles	Louisiana
Calcined Clay	4.57	Burgess	Sanders-ville	Georgia

Alternatively, thermoplastic component 20 may be provided by an alternate formulation of the third extrudate 68 in the form of a highly paintable thermoplastic cap 20. A preferred extrudate formulation is illustrated in Table IV, wherein the principal ingredients of that extrudate are Styrene Acrylonitrile (SAN) and Acrylic Styrene Acrylonitrile (ASA).

TABLE IV

ASA Cap

INGREDIENT	PERCENT	SUPPLIER	CITY	STATE
SAN B-578	69.125	GE	Morgantown	West Virginia
ASA B-984	29.625	GE	Morgantown	West Virginia

INGREDIENT	PERCENT	SUPPLIER	CITY	STATE
EBS Advawax 280	0.50	Morton	Cincinnati	Ohio
Calcium Stearate	0.50	Synpro	Cleveland	Ohio
UV Absorber	0.25	GE	Morgantown	West Virginia

An alternate embodiment of the multi-composite polymer/wood fiber extrusion 10' is shown in Figure 6. This alternate embodiment employs a first thin wall, high density, hollow component 12, substantially identical to the corresponding component of Figure 1. In addition, a second, low density foamed thermoplastic component 16 is employed which is also identical to that shown in Figure 1, with a corresponding reference numeral. However, the extrusion 10' of Figure 6 has a first component 12, having a slightly different shape in profile, including an intermediate web portion 80, dividing the interior cavity 14 shown in Figure 1 into twin cavities in which the second, low density foamed thermoplastic component 16 resides. The alternate embodiment 10' also includes a thermoplastic cap 20 identical to that shown with respect to the first embodiment 10 shown in Figure 1. However, the alternate embodiment 10' is provided with a further, low density foamed thermoplastic component 82, intermediate the thermoplastic cap 20 and the exterior surface 18 of the thin wall, high density component 12. The further, low density foamed component 82 may be formed from an extrudate having a composition identical to the second, low density foamed thermoplastic component 16, as shown in Table II hereinabove.

The alternate embodiment 10' of the multi-component extrusion shown in Figure 6 is manufactured utilizing a modified form of the die assembly 40 shown in Figure 2. In this alternate embodiment, the mandrel plate 52 is replaced with an alternate mandrel plate design 52', shown

in Figures 7a and 7b. In this alternate embodiment, the first mandrel 53(a)' is provided with a first section 84 and a second section 86, interconnected by a fin 88. Each of the sections includes an outer, hollow mandrel 90 and an inner, floating mandrel 92, having a solid cross-section. Each of the mandrels is supported by a plurality of fins, shown with respect to the first embodiment. In addition, the alternate embodiment of the mandrel plate 52' is provided with a tertiary extrudate inlet 94, which is in fluid communication with an internal tertiary conduit 96 for introduction of a tertiary extrudate which will result in the further, low density foamed component 82, shown in Figure 6. The tertiary extrudate may have the same formulation as shown in Table II with respect to the secondary extrudate 66 and second, low density foamed thermoplastic component 16 of the first embodiment 10.

Further alternate embodiments of the invention are contemplated. By way of example and not limitation, the capstock material 20 of alternate embodiment 10' may be eliminated, and the tertiary extrudate which forms the further, low density foamed component 82 may be replaced with a formulation having a significant wood flour component and improved paintability characteristics resulting from the formulation illustrated in Table V, below, in which the principal thermoplastic component is Styrene Acrylonitrile (SAN) polymer resin.

TABLE V

SAN/Wood Flour Foamed Composite

INGREDIENT	PERCENT (by weight)	SUPPLIER	CITY	STATE
SAN Resin	70-90	Kumho		South Korea
Wood Flour	5-25	American Wood Fiber	Schofield	Wisconsin

INGREDIENT	PERCENT (by weight)	SUPPLIER	CITY	STATE
ABS Modifier	2-8	GE	Morgantown	West Virginia
Lubricant	0.1-0.5	Synpro	Cleveland	Ohio
Foaming Agent 80-428-1	0.5-3.0	Color Matrix	Cleveland	Ohio

In each of the above-described embodiments, all of the components exit the second capstocking die plate 58 in a molten (i.e. plastic) state and are introduced into a calibration unit (not shown) where the extrudate is cooled to shape. The resulting multi-component extrusion is preferably cooled further in a conventional cooling tank. Subsequent thereto the resulting extrudate enters a puller before it is cut to length by a saw subsequent to assembly into a window frame or the like.

The above described methods and apparatus are also applicable for the production of decking and siding. By way of example, a third, alternate embodiment of the invention is generally indicated at reference numeral 10'' in Figure 9. This embodiment employs a component structure substantially identical with respect to the second embodiment 10' shown in Figure 6 where like reference numerals refer to like structure. As will be appreciated by those of ordinary skill in the art, appropriate materials can be selected from those shown in Tables I through V above to achieve the desired macroscopic mechanical properties and weather resistance of the resulting multi-component extrusion 10''. Similarly, a decking material can be provided in the form shown with respect to the first preferred embodiment 10, shown in Figure 1. In this alternate embodiment the cross-sectional shape of the extrusion is substantially identical to decking in the form of standard dimensional

lumber wherein the multi-component composite decking extrusion has a foam composite core shown at reference numeral 16 in Figure 1, surrounded by a composite shell core corresponding to reference numeral 12 of Figure 1, and a cap corresponding to reference numeral 20 in Figure 1.

In view of the above, the invention is not to be limited by the above disclosure but is to be determined in scope by the claims which follow.